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Nuclear Testing in an Hour

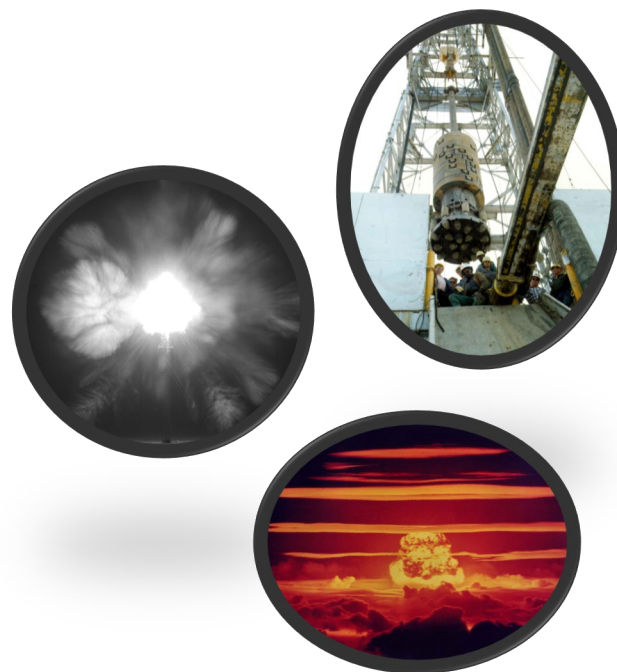
Alan Carr

A PowerPoint presentation that covers the history of nuclear testing from 1945 to 1992. The presentation gives a historical overview of the topic and covers both above ground and underground testing.



Nuclear Fundamentals Orientation

Introduction to U.S. Nuclear Testing: 1945 to 1992



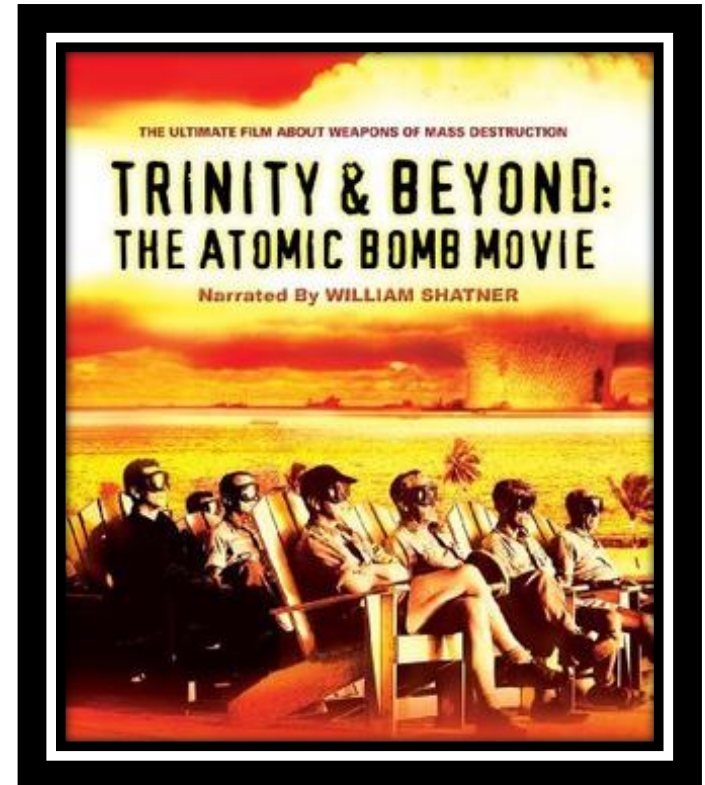
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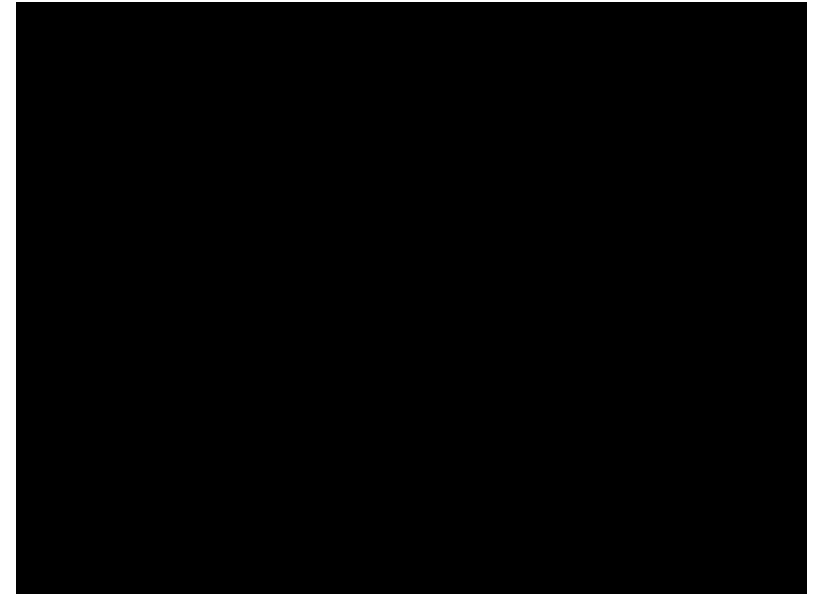
The Moscow Symphony Orchestra



Available at atomcentral.com

Some of the Reasons the U.S. Tested:

- The world's first nuclear test was conducted to ensure the implosion weapon (Fat Man) would work
- The Department of Defense sponsored weapons effects tests
- Most tests were intended to advance weapons design (e.g., adjust yields, improve efficiency, etc.)
- A handful of tests validated the reliability of weapons in the stockpile
- There were a few full-system tests
- Tests were also performed to understand and improve the safety of nuclear weapons
- Vulnerabilities needed to be assessed
- Some nuclear devices were detonated for non-weapons purposes (e.g., nuclear fracking, excavation, etc.)

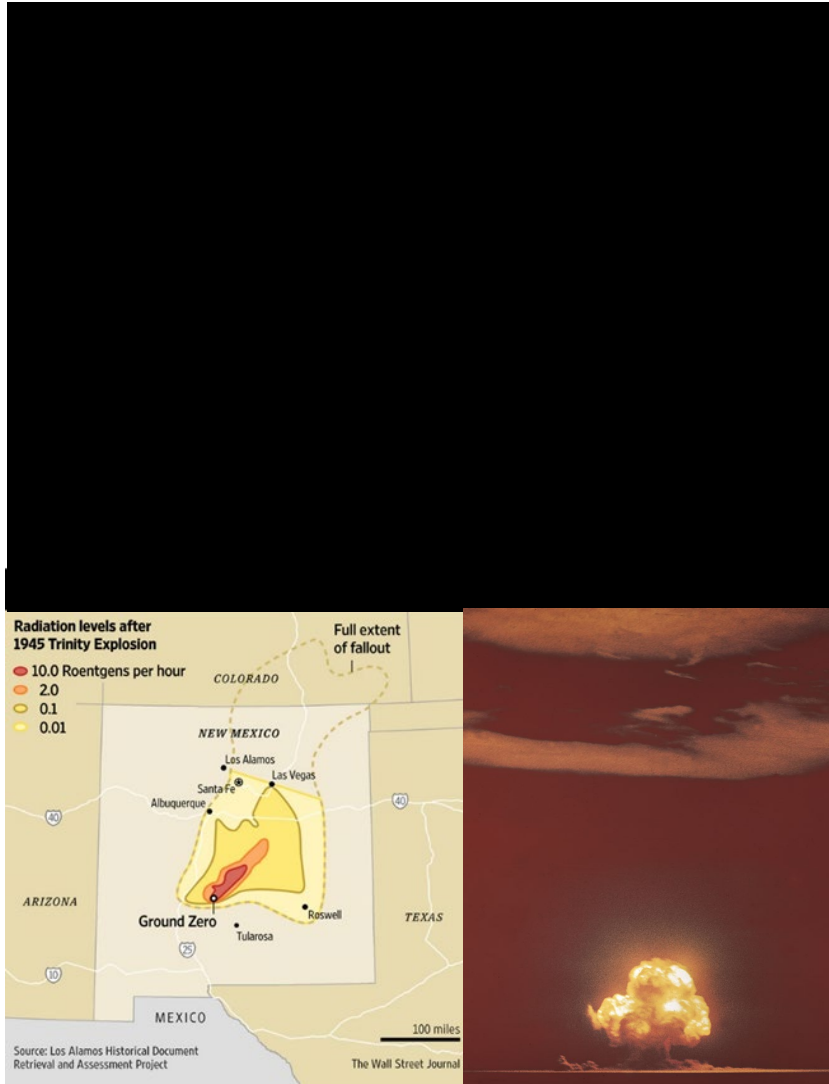


The Original Reason for Testing: Will it Work?

No one was content that the first trial of a Fat Man (F.M.) gadget should be over enemy territory, where, if the gadget failed, the surprise factor would be lost and the enemy might be presented with a large amount of active material in recoverable form.

- Kenneth Bainbridge, Trinity Test Director

Trinity: History's Greatest Scientific Experiment?



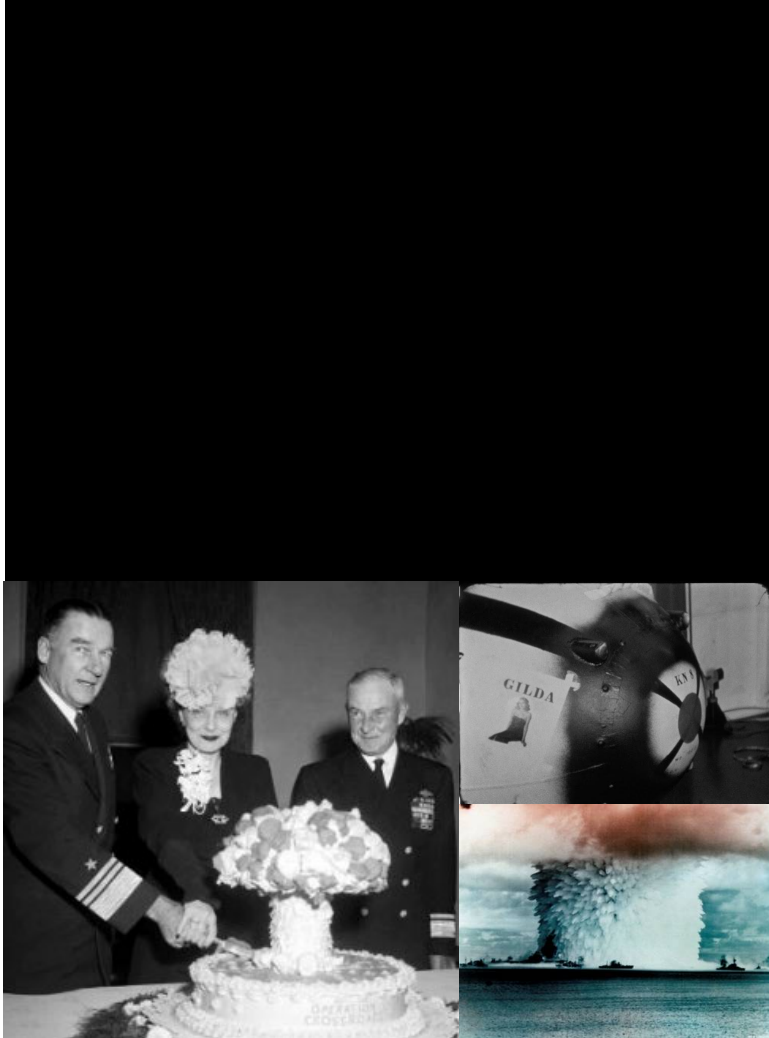
- Los Alamos scientists knew Little Boy, the uranium gun weapon, would work
- However, they were not certain Fat Man, the imploding plutonium bomb, would perform in combat
- J. Robert Oppenheimer dubbed the world's first nuclear test "Trinity"
- Detonation occurred at 5:29:45 the morning of July 16, 1945
- Trinity produced a yield of 21 kt
- Unlike Little Boy, implosion weapons could be produced quickly
- On August 9th, Fat Man was dropped on Nagasaki, Japan

Our first feeling was one of elation, then we realized we were tired, and then we were worried.

— Victor Weisskopf, T Division Group Leader



Crossroads: The Navy Saves Los Alamos



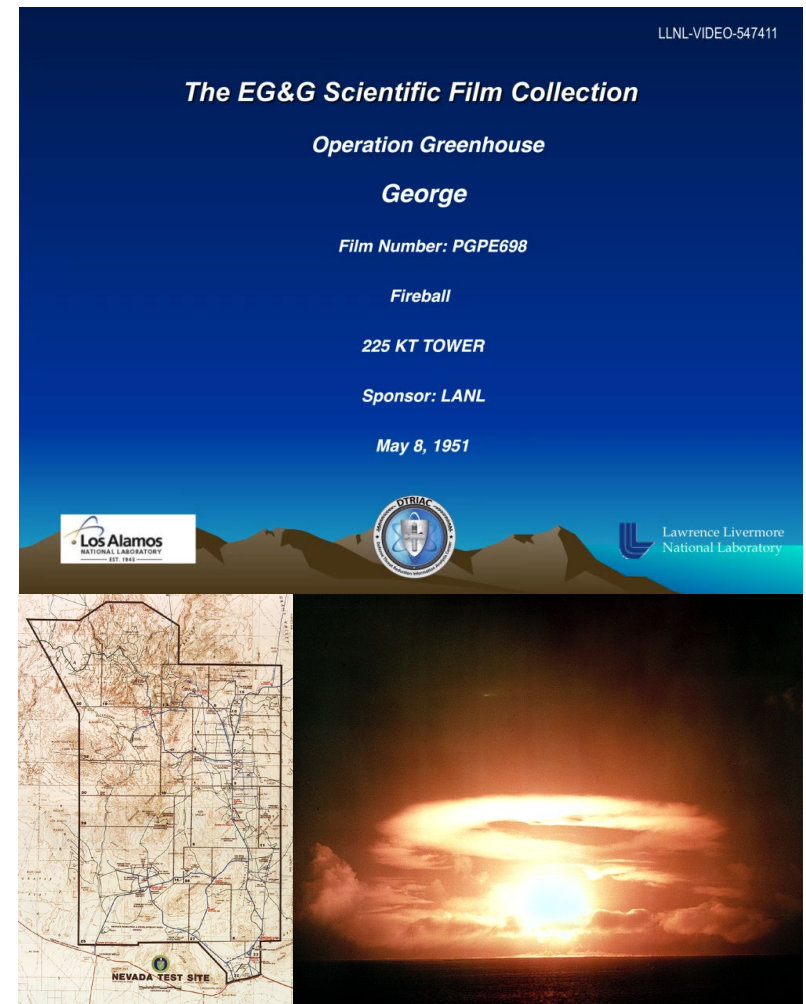
- After the war, the Laboratory needed a customer
- The Navy wanted to see if the fleet could survive nuclear attack
- In Operation Crossroads, the Navy used two Los Alamos weapons against a fleet of captured and surplus ships
- Crossroads was purely a weapons effects series; it did not advance weapons design
- A relatively small number of ships sank, but many were heavily damaged/irradiated
- At that point in time, President Truman still hoped to eliminate nuclear weapons

I am not an atomic playboy!

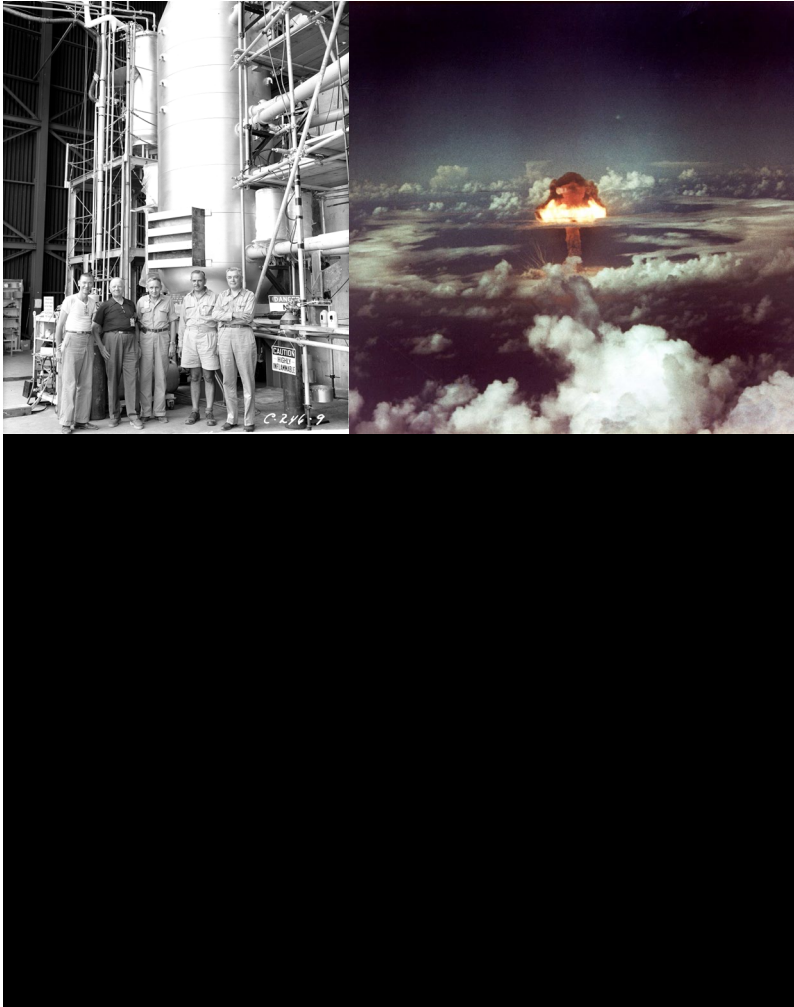
- Vice Admiral W.H.P. Blandy

Milestones in the Early Days of Testing

- As the Cold War solidified, so too did the Laboratory's future
- In 1948, Operation Sandstone was the first series to advance weapons design; the yield basically doubled
- In August 1949, the Soviet Union tested its first weapon: a copy of Fat Man made possible by Los Alamos spies
- In 1951 the Nevada Test Site (originally the Nevada Proving Ground and today NNSS) was established
- The first test conducted there was Ranger-able on January 27th
- Greenhouse-George, on May 8, 1951, was the first test to produce thermonuclear burn (225 kt)
- Greenhouse-Item, on May 24th, was the first test of boosting (45.5 kt)



1952: Operation IVY



- Enrico Fermi first proposed the idea of a thermonuclear bomb in September 1941
- Such a weapon would use a fission bomb to start a vastly more powerful fusion reaction
- Though there was a wartime “super” group, it made little progress
- Edward Teller and Stan Ulam jointly produced a breakthrough concept
- On October 31, 1952 Ivy Mike became the world’s first full-scale thermonuclear device (**10.4 Mt: 700 x more powerful than Little Boy!**)
- On November 15, Ivy King was tested
- At 500 kt, it was the largest fission-only device the U.S. ever tested

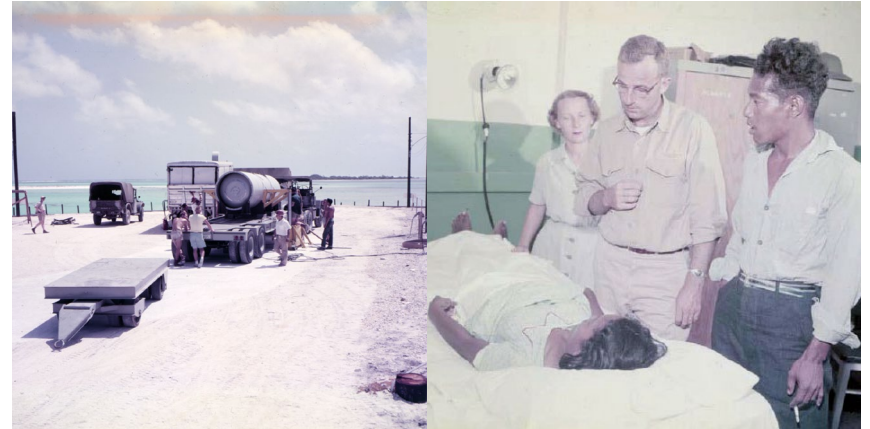
The Advent of Tactical Nuclear Weapons



- As the arms race accelerated, the Soviet Union continued to rely heavily on conventional numerical superiority
- In response, the United States relied on superior technology and firepower
- Part of that doctrine included the development of atomic artillery
- Such weapons, which could operate despite inclement weather, offered pinpoint accuracy and tactical agility
- The first tactical nuclear weapons system was an 280mm canon dubbed “Atomic Annie”
- Upshot-Knothole Grable was conducted May 25, 1953 (15 kt)
- The shell travelled seven miles before detonating 500 feet above the ground

Weaponizing Fusion: Operation Castle

- On August 12, 1953, the Soviet Union tested a deliverable thermonuclear weapon
- In response, the United States conducted Operation Castle in the spring of 1954
- The Castle devices were America's first deliverable thermonuclear weapons
- The first (of six) tests was Bravo
- At 15 Mt (**1,000 x more powerful than Little Boy!**), Bravo was significantly more powerful than predicted
- ~236 Marshallese Islanders were evacuated on an emergency basis
- The danger of fallout gradually eclipsed the Soviet Union as a threat

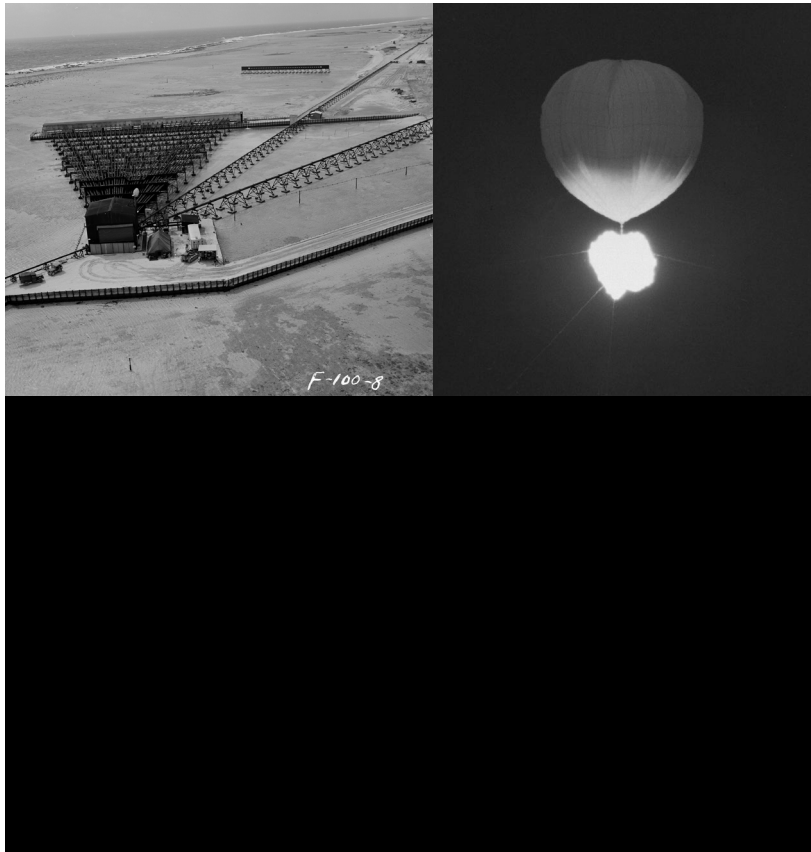


Let Bert Show YOU How to Survive a Nuclear War!



- The Civil Defense (CD) Program became an extension of deterrence
- Especially in the days prior to Mutual Assured Destruction (MAD), much thought was given to surviving nuclear war
- Many weapons tests during this era focused on the survivability of civilian and military assets
- But as nuclear stockpiles and weapons yields grew to enable MAD, CD very gradually received less emphasis

Hardtack: Running to Stand Still



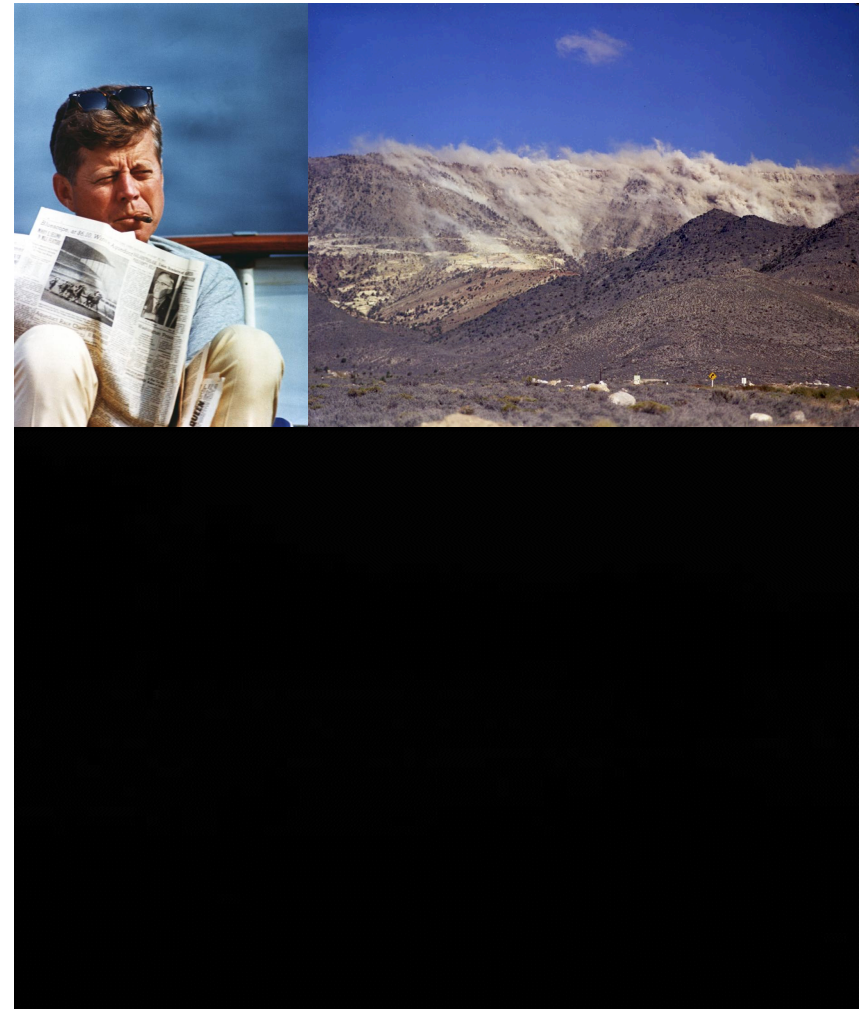
- Hydrogen bombs were greatly refined in Operation Redwing (1956)
- 28 tests were performed in Plumbbob (1957), the largest series to date
- Though the Soviets entered a unilateral test moratorium, Operation Hardtack began: 34 tests between April 28 and Aug. 18, 1958
- After announcing the U.S. would enter a test moratorium at the end of October, Hardtack II began: 36 tests in 49 days!
- Most shots were safety tests
- In November 1958, the Soviet Union and the United States entered a year-to-year test moratorium
- Nonetheless, in the years 1959 through 1962, the U.S. built nearly **24,000 pits!**

(what's taking so long, TA-55???)

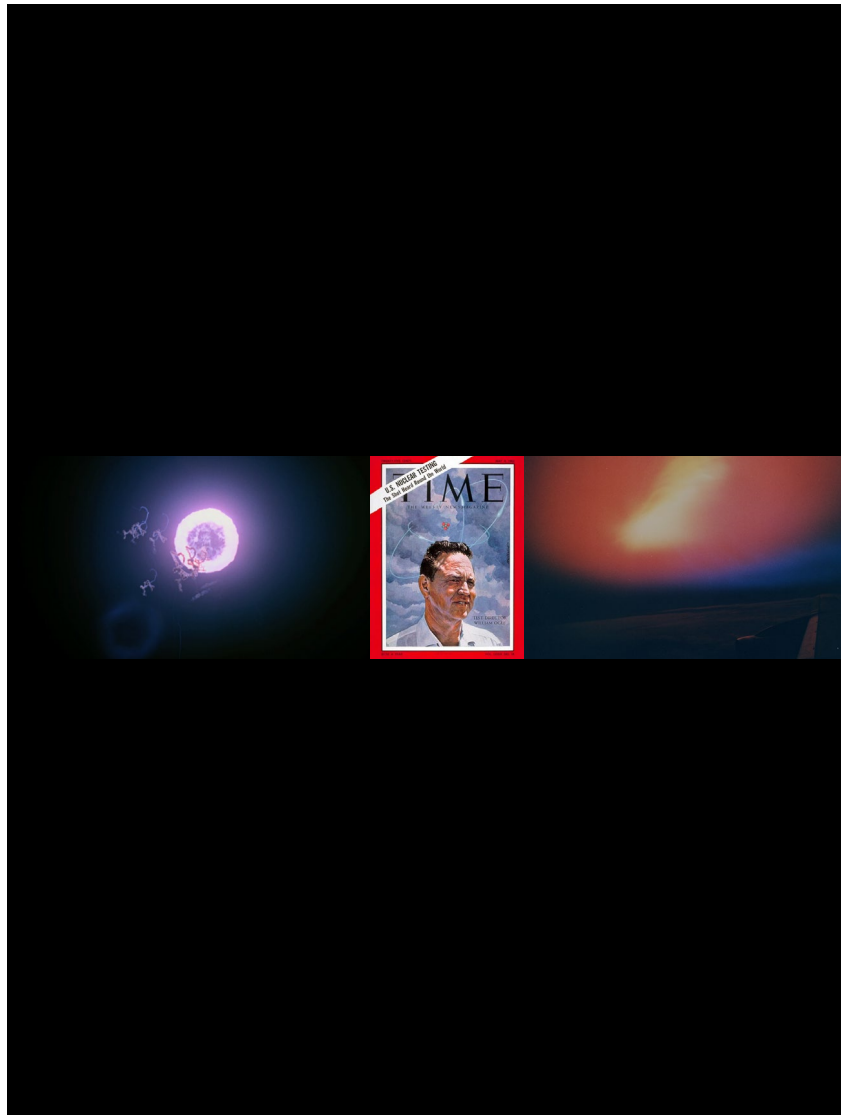


Nougat: “The LASL Goes Underground”

- **SURPRISE:** The Soviet Union resumed testing (with only one day’s notice) on September 1, 1961
- They would go on to perform **59 tests in the next 65 days:** the largest series by megatonnage in history!
- September 15: The first U.S. test was Nougat Antler, a Livermore shot (2.6 kt)
- It leaked! ... but all 10 of the tests conducted in 1961 leaked
- Los Alamos fired Shrew the next day (“low” yield)
- On October 30th, the Soviet Union tested the largest bomb of all time: the **~50 Mt “Tsar Bomba”**
- 50 Mt is the equivalent of nearly 3,500 Little Boys!



The Final Days of Atmospheric Testing



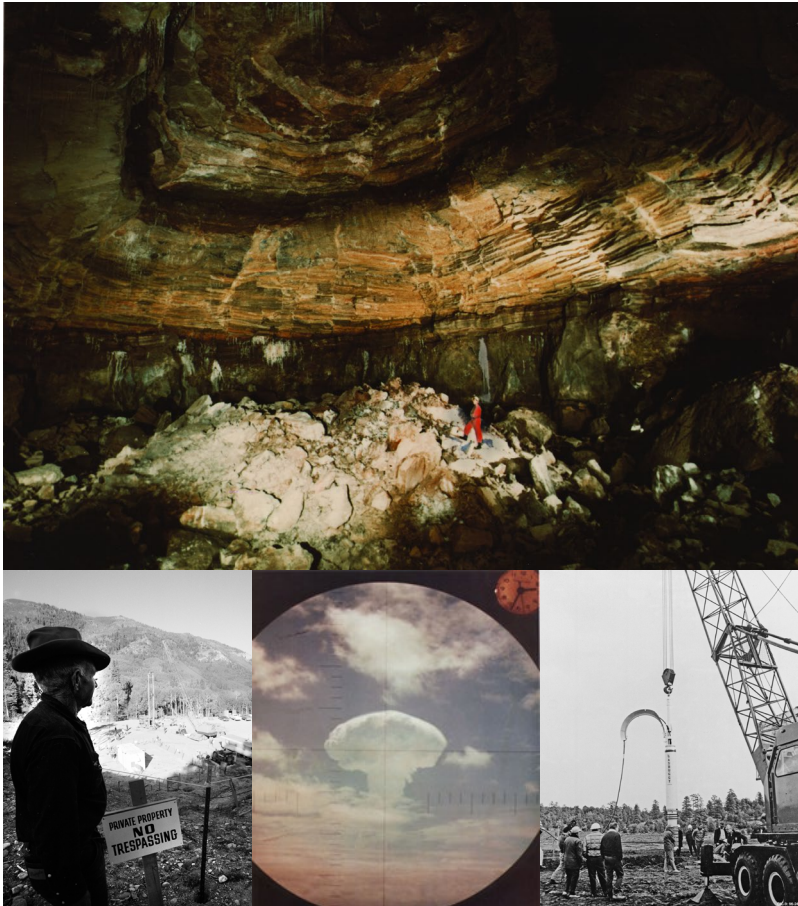
- Spurred by the Tsar Bomba test and the fear of lagging in EMP research, the U.S. resumed atmospheric testing
- The final days of U.S. atmospheric testing ran from April 25, 1962 to Nov. 4, 1962
- Little Feller I: Last atmospheric test at Nevada, a full-system test of a Davy Crocket, was conducted July 17
- The Cuban Missile Crisis unfolded; nuclear war was narrowly averted
- Dominic-Tightrope: A week after the crisis ended, LASL performed the final U.S. atmospheric test (Nov. 4)
- Less than a year later came the Limited Test Ban Treaty (Oct. 10)
- Testing continued underground

Going Underground for Good (...kinda!)

- A vast majority of tests were conducted underground in Nevada
- Boxcar (4/26/68) was the largest test at NTS (UGT or otherwise): 1.3 Mt
- 158 vertical shafts leaked (39 LANL, 119 LLNL) during the era of testing
- A Livermore test, Emery-Baneberry, changed everything (12/18/70)
- Only a few tests leaked after the Baneberry disaster; those were relatively minor
- 1974: The Threshold Test Ban Treaty limited explosions to 150 kt, but didn't enter force until 1990
- The last Soviet test was conducted on October 24, 1990
- NTS hosted 904 tests (804 UGTs)



Where Else Did We Test?



The U.S. also performed tests in central Nevada; near Fallon, Nevada; in the Johnston Island area; in the Christmas Island area; and at sea in the Pacific.

- In the late summer of 1958, Los Alamos performed three tests in the South Atlantic (Operation Argus)
- In addition to Trinity, New Mexico hosted two more tests: Gnome (12/61) and Gasbuggy (12/67)
- Both were Livermore Plowshares tests
- In 1964 and 1966, Livermore performed Vela Uniform tests near Hattiesburg, Mississippi
- In 1969, Los Alamos performed a Plowshares test called Rulison near Colorado's Grand Valley
- Los Alamos and Livermore performed three tests near Amchitka, Alaska
- In 1973, Livermore detonated three devices simultaneously near Rifle, Colorado; another Plowshares test

The Last Act: Operation Julin



- Between 1945 and 1992, the U.S. conducted 1054 nuclear tests
- By the late 1980s, it was becoming clear testing would end
- Weapons in the stockpile were (*are!*) robust, sophisticated and could fulfill all the missions set forth by the military
- But they were not designed to last forever: enter Stockpile Stewardship
- The Senate voted for a nine-month testing moratorium on September 13, 1992; it would go into effect at the end of that month
- What proved to be the last U.S. full-scale test was conducted September 23, 1992
- During the era of testing, it has been estimated the U.S. produced ~190 Mt of energy (USSR, ~285 Mt)



How Do We Test Today?

- It's been nearly 30 years since the U.S. performed a full-scale test!
- Full-scale testing was an enormous advantage your predecessors had!
- They didn't need to fully understand phenomena associated with testing
- In the past, Los Alamos performed fission-producing hydronuclear tests
- Today, we use a variety of tools to assess the stockpile:
 - DARHT
 - Subcritical Testing in Nevada
 - The Centrifuge Facility
 - The Blast Tube Facility
 - The Trinity Supercomputer
 - Approximately 1000 experiments each year
- And it's a good thing we have these tools: **Today's technical challenges, are both exciting and essentially unprecedented!**



Nuclear testing was a wonderful tool. It was also the world's biggest shortcut. It meant that we didn't have to understand all the details of a nuclear weapon and how it functions.

- Joe Martz, RRW Program Manager



Testing Trivia

- The U.S. conducted 1,054 full-scale nuclear tests (1,033 + 24 joint U.S.-U.K.)
- More tests were conducted in 1962 than in any other year: 96
- There were 210 atmospheric tests, 815 underground tests and 5 underwater tests
- 106 tests were performed in the Pacific; 3 in the Atlantic
- 904 tests were conducted at the Nevada Test Site, an area larger than Rhode Island (1,351 vs. 1,212 square miles)
- Jangle-Uncle was the first “official” underground test (UGT) according to DOE
- Pascal-A was the first *real* UGT
- Livermore’s Rainier test (1.7 kt) of 9/57 was the first successfully contained UGT
- Plumbbob-Hood (74 kt) was the largest atmospheric test at the Nevada Test Site

